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**AVATARS, MEDIA USAGE, AND THE LINKAGES TO  
E-LEARNING EFFECTIVENESS**

THESIS

Jason P. Royals, MSgt, USAF

AFIT/GIR/ENV/11-M05

**DEPARTMENT OF THE AIR FORCE  
AIR UNIVERSITY**

***AIR FORCE INSTITUTE OF TECHNOLOGY***

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**Wright-Patterson Air Force Base, Ohio**

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AFIT/GIR/ENV/11-M05

AVATARS, MEDIA USAGE, AND THE LINKAGES TO  
E-LEARNING EFFECTIVENESS

THESIS

Presented to the Faculty

Department of Systems and Engineering Management

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in

Information Resource Management

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Master Sergeant, USAF

March 2011

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AVATARS, MEDIA USAGE, AND THE LINKAGES TO  
E-LEARNING EFFECTIVENESS

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### **Abstract**

A fast-growing trend in e-learning environments is the investment in avatar technology to deliver an engaging and interesting learning experience. E-learning itself has limited and inconsistent research into its learning effectiveness, and this is especially true for innovative avatar instructional methods. The purpose of this research was to develop a generalizable theory that can be used to assess the learning effectiveness of various media types used in e-learning environments. A research model was developed and used to study a U.S. Air Force Squadron Officer School Distance Learning program that used avatar, video, audio, and text-based scenarios to reinforce learning objectives. It was hypothesized that media with higher levels of learning engagement would lead to more favorable reactions and thus higher levels of understanding. While text and audio showed positive learning engagement results, the hypotheses for both avatar and video influence on learning engagement were not supported. Results also showed full and partial support for learning engagement leading to favorable learning outcomes. The model developed in this research identified the learning effectiveness of an e-learning program and can be used to guide education and training investment decisions based on proven learning outcomes rather than the surface appeal of emotional interest and engagement features.

AFIT/GIR/ENV/11-M05

*For my wife and kiddos.*

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Jason P. Royals



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# AVATARS, MEDIA USAGE, AND THE LINKAGES TO E-LEARNING EFFECTIVENESS

## I. Introduction

*“I have no special talents. I am only passionately curious.”*

*- Albert Einstein*

E-learning is defined as “training delivered on a computer that is designed to support individual learning or organizational performance goals” (Clark and Mayer, 2008). As e-learning continues to grow in popularity, the use of avatars is the latest innovative trend in organizational education and training environments. An avatar has been described as an animated character who guides learners through a course of e-learning (Fee, 2009). The most noticeable impact avatars are having on learning is the widespread adoption of the technology along with a great deal of trust placed in its ability to produce required learning results. An American Society for Training and Development study showed an estimated \$125.88 billion was spent by U.S. organizations in 2009 on employee learning and development, with 36% of that spent on e-learning (Patel, 2010). Unfortunately, as substantial investments on avatar innovations and other e-learning methods take place, there is very little research to support learning outcomes.

### ***IT-Performance Paradox***

Organizations seeking to maximize value and performance by adopting e-learning systems may be falling victim to the *IT-performance paradox* as described in a 2008 perspective of the *prisoner’s dilemma* (Tangpong, 2008). The IT-performance paradox suggests that while information technology (IT) innovations promise performance

improvements, often it is only the vendors who realize any gains. The marketing of e-learning systems has made the technology a ubiquitous commodity simply by targeting organizations with education and training needs. In a rush to gain performance improvements while satisfying budget efficiencies, a “bandwagon” effect has occurred as organizations jump on board with the latest innovative learning systems *even when there has been no empirical evidence to show significant improvement in performance or efficiencies*. The result of such a paradox, as Tangpong observes, is there may be no real value created for investors, leaving only the vendor(s) with any substantial value/payoff. The paradox can also be attributed to what Bates and Poole describe as a *technological imperative*: “One frequent criticism of the use of technology for teaching in academic circles is that we are being driven by a technological imperative: we have to use technology because of a blind belief that it is good for us. If we don’t agree to the use of technology, we will be considered out of date and may lose our credibility” (2003).

### ***Total Cost of Ownership***

Aside from the initial e-learning software purchase(s), there are typically other costs involved, such as the subsequent hardware upgrades that accompany e-learning investments. For example, Sheldon Parks, the gaming integrator for the U.S. Army Training and Doctrine Command’s Capability Manager for Gaming, said that in a move to “make every piece of hardware in the battle command centers gaming-capable,” the Army is upgrading the video cards and microprocessors in computers at all Battle Command Training Centers (Peck, 2011). Although important, this initial implementation commitment and the subsequent total cost of ownership (TCO) factors (technical support, training, maintenance, lifecycle replacements, and so on), should be

*secondary* to the question of *whether or not the learning technology is effective to begin with*. This study posits that there is no justification for the amount of spending on e-learning taking place today without empirical evidence of the method's learning effectiveness.

### ***The Unstoppable Force***

Research into the e-learning trend is limited, inconsistent, and inconclusive (Bostrom and Gupta, 2009). Current studies reaffirm past findings that show there are no significant differences in e-learning outcomes as compared with face-to-face instruction (Carrol and Burke, 2010), and continue to declare a need for more research into e-learning effectiveness (Mayer, 2005; Gupta and Bostrom, 2010). Furthermore, the TCO and short lifecycles of modern technology may be prohibiting overall cost-savings while continually presenting researchers a moving target that hinders the establishment of any meaningful learning theories that can shed light on the effectiveness of modern e-learning instructional system designs. However, e-learning has been considered an “unstoppable force” (Spencer, 1999), and if that is so, it is imperative that the research and education community collectively confront the task of determining how to maximize learning outcomes in our e-learning environments.

### ***The e-Learning Marketplace***

The continuous and rapid growth of technology has allowed the development and implementation of a flood of multimedia e-learning environments, many of which are implemented with the assistance of accommodating vendors who tend to place a heavy emphasis on the technological characteristics of instructional system designs, and little on

the learning content. Fee describes why he feels there is such a technology focus in the e-learning marketplace:

There are three component parts of e-learning, namely enabling technology, learning content and learning design. People tend to focus on the first, the technology, because this is the new and unfamiliar component, but the other two are at least as important. Software vendors tend to place great emphasis on the first, because that is what they contribute, and where they make their living, but that does not mean that learning and development professionals need to follow suit (p. 16).

### ***Scientific Approach***

As the emotional appeal of innovative learning technologies used in e-learning continues to grip the education and training landscape, attention needs to be turned more toward the fundamentals and outcomes of learning. The *multimedia principle* states that: “People can learn more deeply from words and pictures than from words alone” (Mayer, 2005, p. 15). This is the basis for most multimedia learning research when considering the differences in delivery methods.

If Mayer’s multimedia principle holds true, the theories and observations presented in this study provide promise and support for the effective use of avatars in e-learning environments. This paper suggests a prudent approach to e-learning by ensuring that *cognitive and learning sciences* are given at least the same attention as the innovative technologies used during the development, acquisition, and implementation of instructional system designs (DeRouin et al., 2005).

### ***The Avatar Advantage?***

The advent of high-speed internet availability has enabled multimedia delivery capabilities never seen before on such a ubiquitous scale. With its innovative virtual



moving pictures, audio features, interactivity and emotional appeal, will avatars used in e-learning epitomize the multimedia principle? It may be they turn out to be a truly revolutionary method for increasing learning effectiveness due to their ability to engage a learner in an e-learning experience. To date, there has been no conclusive evidence to show the use of avatars lead to favorable learning outcomes over other media channels and can therefore can only be viewed as a speculative instructional technique at this point. This study seeks to discover how the use of avatars and other media channels affect learning engagement and discover if avatars do indeed hold a definitive learning advantage over other media channels of instruction.

### **Research Objectives**

The purpose of this research is to gain insight into the impact media usage has on an e-learning environment by determining which media channels influence favorable learning outcomes most effectively. This study is an attempt to turn an overwhelming focus away from the “technological imperative” mindset and toward a “learning imperative” that accentuates the use of cognitive and learning sciences. To do this, the study examines how different media types (1) induce learning engagement, (2) invoke learner reactions, and (3) influence learning.

### **Implications**

This study fills a research gap in the area of using e-learning to increase the effectiveness and efficiency of learning programs (Bostrom and Gupta, 2009), provides guidance for making informed decisions about educational investments, and will benefit future research by exploring methods for improving e-learning systems.

## Problems to be Investigated

Emerging technologies continue to offer new ways of approaching the education and training needs of organizations. Many times these innovative instructional methods gain widespread acceptance while still in their developmental infancy and without any empirically validated research to demonstrate their affects on learning outcomes. Avatar technology is an example of one such innovation. This study has introduced the avatar channel into the research stream with the primary goal of developing an increased understanding of how e-learning media channel options influence learning outcomes.

To achieve this goal and help fill a gap in existing e-learning research, the following research question was developed: *To what extent does the use of avatar, video, audio, and text-based instructional technologies impact learning outcomes in an e-learning environment?* In order to gain the necessary insight to answer the overarching research question, this thesis will focus on the following three core investigative questions:

- (1) *To what extent does media usage in e-learning environments affect learning engagement?*
- (2) *To what extent does learning engagement affect learning affective and cognitive reactions?*
- (3) *To what extent do learner affective and cognitive reactions affect subjective learning outcomes?*

## **Methodology**

This study used a quantitative research methodology and was accomplished through the analysis of data gathered from a survey instrument using Likert-scale items. These items were developed to measure learning engagement, affective and cognitive reactions, and subjective learning.

## **Thesis Overview**

The topics discussed in this chapter included the background, purpose and significance of the study, problem to be investigated, and research methodology. The next chapter (chapter two) provides an extensive review of relevant theories/models related to information technology and educational psychology, specifically addressing media usage linkages with learning engagement and learning outcomes. Based on the literature review, hypotheses were developed pertaining to how the use of different media channels would influence learning engagement, and lead to certain learning outcomes. Chapter three then discusses the research design, sample characteristics, procedure, and measures that formulate the methodology used in this study. Next, chapter four examines the quantitative data acquired from the data collect with emphasis on the statistical significance of the findings based on the hypotheses proposed in this study. Finally, chapter five provides a summary of the findings, limitations, theoretical implications, applications, and opportunities for future research.

## II. Literature Review

### Overview

The primary purpose of this literature review is to assess the current state of knowledge with respect to the influencing elements of media channels in hopes of understanding how and why people learn most effectively in e-learning environments. This review lays the groundwork required to help fill a research gap that exists in the area of cognitive learning *processes* in organizational-based settings (Bostrom and Gupta, 2009), and is structured as follows.

First, a background of the literature is presented. Second, a description of the theoretical foundations applied to this study. Then, the media channels examined in this study are discussed. Finally, the links between media usage, learning engagement, and learning outcomes are presented along with the hypotheses developed.

### Background

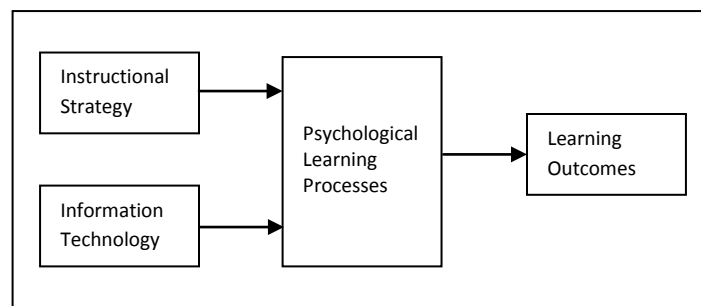
E-learning has revolutionized education and training by introducing innovative methods of instruction and breaking the traditional constraints of time and location through the enabling global reach of the Internet (Brown and Adler, 2008). However, a cautious approach to such innovations has been advised in the wake of the *technological imperative* mentioned earlier that states people are persuaded to implement technological solutions for fear of losing credibility and do so with a blind believe that technology is somehow good for them.

In order to most effectively develop and use e-learning systems, a greater understanding of how people learn in these environments is needed. With a focus on the

area of media usage and its impact in e-learning, this section examines relevant literature associated with learning engagement, information technology theory, and learning outcomes to help reveal optimal learning conditions in e-learning.

### **Theoretical Foundation**

The theoretical underpinnings of this study are based on research into information technology and educational psychology, specifically learning engagement and learning outcomes. This theoretical approach was adopted from the concepts built into the Alavi and Leidner (2001) framework for e-learning research (Figure 1). For the purposes of this research, the information technology portion of this framework refers to the enabling capabilities that allow the delivery of the four media channels used in this study. Consistent with the framework, it is theorized here that media usage will initiate various levels of learning engagement, thereby triggering the psychological learning processes that ultimately determine learning effectiveness.



**Figure 1. A framework for e-learning research (Alavi and Leidner, 2001)**

## **Media Usage**

Four optional media channels were examined in this study to determine how their usage affected learning effectiveness: text, audio, video, and avatar. Some media required the user to be actively connected to the e-learning program for content access, whereas others allowed printing and downloadable access.

The media channels were instructional methods a user could choose to engage in to reinforce their understanding of course objectives. Each channel was used independent of the other; however, some may have contained an element of the other. For example, video and avatar also include audio channels, however those elements were considered inherent to that particular instructional method. The four channels are explained briefly as follows:

### ***Text***

Coupled with mandatory reading assignments, optional text scenarios were presented along with projects to be completed such as written analysis and after-action report presentations. Users could view the text either through HTML, PDF format and had the option to print the material for off-line reading at a location of their choosing. There was no immediate feedback provided to confirm understanding or report performance results.

### ***Audio***

Provided through downloadable MP3 files that could be listened to while following along with course modules, or taken with the learner and listened to anywhere

as a “podcast.” Once again, this was a media option and had no immediate feedback to ensure understanding. Myriad influx

### ***Video***

Video was presented as prerecorded video lesson material and meant to reinforce current learning objectives. Users had to be located at a computer terminal and have internet access. There were no additional assignments or immediate feedback provided to confirm understanding.

### ***Avatar***

4) *Avatar*: Presented as vignettes that animated short (one to two minute) learning scenarios designed to reinforce current learning objectives. A multiple choice question and answer session followed immediately after each scenario and an explanation of right and wrong answers was provided.

## **Learning Engagement**

Learning engagement has been defined as “the student’s psychological investment in learning...the amount of time they spend, the intensity of their concentration, the enthusiasm they express, and the degree of care they show” (Newman, 1989).

Engagement has been determined to be a shortfall in DL programs (Salas et al., 2005, cited in Johnson et al., 2009) and DL has been considered “...not necessarily more motivating and can mislead students into investing less mental effort to learn” (Clark, 2009). However, if used properly, positive results have been demonstrated using information technology to induce learning engagement (Chen, et al., 2010). As an antecedent to learning reactions, research has shown *engagement* to be an effective

enabler of desirable learning outcomes by establishing interest and building excitement in the learner (Carini, et al., 2006).

### **Media Usage and Learning Engagement Linkages**

Learning effectiveness will depend on how effective the communications are between the educator and student in a learning environment. Based on information technology communication and cognitive theories, the relationship between media channels and learning engagement needs to be specified. To develop the hypotheses of this research, the media richness theory, media synchronicity theory, and emotional interest theory were used to predict media usage and learning engagement.

#### ***Media Richness Theory***

Daft and Lengel described media richness theory as the “learning capacity of a communication” (1986). Developed to help identify the most effective media for a given communication task, this theory suggests *avatars* have an advantage over the other channels due to the *immediate feedback* provided through its question and answer feature and its ability to present *multiple cues*, such as vocal inflections and non-verbal gestures. Additionally, through its virtual representation of people, avatars possess a “*social presence*,” which has been suggested to induce motivation when coupled with a rich media (Dennis, 2005). Considered the richest media, avatars were predicted to be the most engaging and result in the most usage.

#### ***Media Synchronicity Theory***

Media synchronicity theory (Dennis, 2008) addresses how to communicate new information most effectively by allowing an appropriate amount of time for processing



the new information. This theory terms the transmission and processing of new information *conveyance*, and the process of reaching a mutual understanding of the information as *convergence*. The appropriate speeds at which conveyance and convergence occur depend on the *complexity* of the information.

With the intent to "generate a shared understanding" (2008, p. 576), the act of learning is considered here to be a communication process between teacher (e-learning instructional method) and student. The media channels used in this study are examined to determine their ability to convey information most effectively in order to ensure the learner reaches a quick understanding of course material.

The use of audio, text, and video channels were often lengthy tasks and provided no immediate feedback. Due to its ability to *facilitate a faster understanding* through its short scenario-based question and answer feature, avatars were again predicted to engage learners most effectively and generate the desired understanding.

### ***Emotional Interest Theory***

Emotional interest theory states that the use of *seductive details*, or irrelevant yet interesting aspects, can *energize* the learner, causing them to pay attention and learn more as a result (Harp and Mayer, 1998). Text, audio, and video channels are predicted to have the least amount of these engaging qualities. Modern avatar instructional methods employ attractive graphical and audio features and are predicted to appeal to those interested in the current educational innovations. Therefore, avatars are once again thought to induce the most learning engagement due to their elements of appeal as highlighted by the emotional interest theory.

## **Hypotheses 1a-d**

*H1(a): Text presentations will have a positive relation with learning engagement.*

*H1(b): Audio presentation will be more engaging than text and account for variance in learning engagement beyond that accounted for by text presentation alone.*

*H1(c): Video presentations will be more engaging than both text and audio and account for variance in learning engagement beyond that accounted for by text and audio presentation.*

*H1(d): Avatar presentations will be more engaging than text, audio, and video and will account for variance in learning engagement beyond that accounted for by text, audio, and video presentations together.*

## **Learning Outcomes: Kirkpatrick's Levels of Evaluation**

In 1959, Kirkpatrick submitted a four-level model that defines techniques for evaluating training programs. The first two levels, *reaction* and *understanding*, address the training environment and its immediate learning outcomes. The second two levels, *behavior* and *results*, address behavioral changes and organizational results caused by the training and are outside the scope of this study. In an attempt to discover the impact of media usage on learning outcomes, this study applied the first two levels of the Kirkpatrick model for measuring learning effectiveness.

### ***Level 1: Reaction***

The first of Kirkpatrick's levels is reaction. Reactions are defined as how trainees respond to a particular training program (Kirkpatrick, 1959). Learner's reactions in this study were measured both affectively and cognitively. Affective reactions are considered to be a learner's feelings about how well they enjoyed the training (i.e., fun/boring; pointless/useful). Cognitive reactions indicate how receptive the learner was to the learning objectives (i.e., easy to understand or confusing).

### ***Learning Engagement and Reactions***

Affective reactions were hypothesized in this study to have a *positive* relationship with learning engagement: the more the learner was energized, the more enjoyable they will perceive the experience (Harp and Mayer, 1997). Conversely, cognitive reactions were predicted to have a *negative* relation with learning engagement.

This negative relation with learning engagement is consistent with Festinger's theory of cognitive dissonance (1957), and is considered a normal part of the psychological learning process. The more an individual attempts to learn, the more they are confronted with ideas that are not completely congruent with their own ontological assumptions. As this happens, their paradigms and psychological schemas are challenged which can be a confusing experience. This results in a state of cognitive dissonance (1957) and disequilibrium that can be uncomfortable.

#### **Hypotheses 2a-b**

*H2(a): Higher levels of learning engagement will lead to higher levels of favorable affective reactions*

*H2(b) higher levels of learning engagement will lead to a negative relation with cognitive reactions.*

### ***Level 2: Learning***

An evaluation of learning is a determination of knowledge acquired, skills improved, or attitudes changed due to the training (Kirkpatrick, 1996). Only subjective learning measures were used in this study to examine a learner's sense of increased knowledge, improved critical thinking skills, heightened cognitive awareness, and so on.

Kirkpatrick’s original model was updated in 2006 to include a “chain of evidence” that accentuates the importance of connecting each successive evaluation level to the next for the most effective learning outcomes, and the linkages between reactions and learning are discussed next.

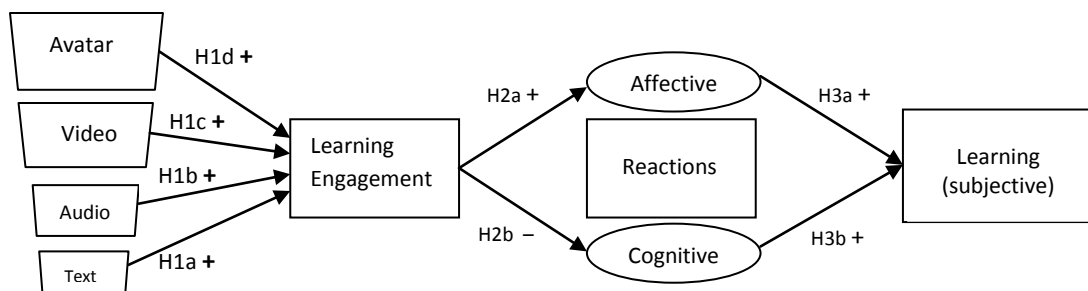
### ***Reactions and Learning***

It was hypothesized in this study that higher levels of both affective and cognitive reactions would lead to higher levels of understanding. The emotional interest theory posits that higher affective reactions (emotional arousal) indicate enjoyment with the learning experience and will likely lead to a stronger attention span thus higher understanding (Harp and Mayer, 1997). Cognitively speaking, it is posited here that as learners faces the challenges presented by cognitive dissonance, sensemaking will eventually occur (Weick, 1979), and *ultimately result in positive relations with the cognitive reactions that lead to higher levels of understanding.*

### **Hypotheses 3a-b**

*H3(a): Higher levels of affective reactions will lead to higher levels of understanding*

*H3(b) higher levels of cognitive reactions will lead to higher levels of understanding.*



**Figure 2. Research model**

### **III. Methods**

#### **Overview**

The purpose of this chapter is to address the methodology used to answer the overarching research question presented in this study: *To what extent does the use of avatar, video, audio, and text-based instructional technologies impact learning outcomes in an e-learning environment?* This chapter examines the research design used in this study, sample population characteristics, location/setting, procedures, and measures used to collect the data.

#### **Research Design**

This study incorporated a quantitative research design accomplished using data collected from a 21-question survey. The survey was comprised of 5-point Likert items that measured the media usage, learner's engagement, affective and cognitive reactions, and subjective learning. The data collected using the applied research design was later analyzed using hierarchical regression, partial correlations, and linear regression and will be covered further in chapter four.

#### **Sample Characteristics**

The sample population used to acquire the data for this research effort consisted of 95 United States Air Force captains (or captain-selects) and other eligible DoD personnel (Air National Guard, Air Force reserve, DoD civilians, Civil Air Patrol, and other US services: Army, Navy, Marine Corps, and Coast Guard) with 5 – 7 years of service. Thirty percent were female and seventy percent were male, and all possessed at least a bachelor's degree.

The survey participants were self-selected and had completed the Squadron Officer School (SOS) Distance Learning program, a military Professional Military Education course designed to teach ethical leadership, decision making, and team building skills to developing leaders.

## **Procedure**

Air Force officers were self-enrolled in the SOS Distance Learning program and were given up to eighteen months to complete the required course material. As they progressed through course modules, they were presented with multimedia options (text, audio, video, and/or avatar) designed to reinforce learning objectives. Upon completion of the course, volunteers participated in an anonymous online survey.

This survey asked for participant's feedback based on their general feelings about the learning experience, the impact of the optional media features, and perceived levels of subjective learning. The survey was composed of single-item usage measures and included: media type used, learning engagement, reactions (Kirkpatrick level 1), and learning (Kirkpatrick level 2).

## **Measures**

*Usage:* This was a 5-point Likert scale measurement and was used to determine how often learners used the optional media features. The scale was comprised of levels from "almost always" to "almost never" and included a "not applicable" option.

The measures for media usage were taken using a 5-point Likert scale with an additional "not applicable" option. Specifically, the participants were asked:

1. *How often did you use optional TEXT features during the course?*
2. *How often did you use optional AUDIO features during the course?*
3. *How often did you use optional VIDEO features during the course?*
4. *How often did you use optional AVATAR features during the course?*

*Engagement:* This scale was adopted from general engagement items similar to those found in Kirkpatrick Level 1 reaction sheets (2008) and guidelines provided by the University of Minnesota Center for Teaching and Learning Services (Ruhe, 2006) .

Example items from this scale included “I devoted my full attention to the course,” and “I put my full effort into completing the course material.” All positively worded items were retained that exhibited low cross loading when subjected to an exploratory factor analysis. An eigenvalue of 1.72 explained 89% of the variance. The coefficient alpha for this scale was .836.

The measures for learning engagement were taken using a 5-point Likert scale. Specifically, the participants were asked to rate the following statements:

1. *I devoted my full attention to the course.*
2. *I stayed focused on the material while working on it.*
3. *I put my full effort in to completing the course material.*

*Reaction:* This scale was based on items similar to those found on Kirkpatrick Level 1 reaction sheets (2008). A single exploratory factor analysis yielded a two-factor solution. The first factor was the 5 item *affective* reaction scale with an eigenvalue of 3.3 that explained 41.4% of the variance. Example items from this scale included, “The course was interesting,” and “Aspects of the course were confusing” (reverse coded).

The coefficient alpha for this scale was .808. The second factor was a 3 item *cognitive*

factor scale with an eigenvalue of 1.7 and explained 21.5% of the variance. The coefficient alpha for this scale was .774.

The measures for reactions were taken using a 5-point Likert scale. Specifically, the participants were asked to rate the following statements:

1. *The course was fun.*
2. *The course was boring.*
3. *The course was interesting.*
4. *The course seemed pointless to me.*
5. *The purpose of the course seemed straightforward.*
6. *The instructions for the course were easy to understand.*
7. *The course material did not make sense to me.*
8. *Aspects of the course were confusing.*

*Understanding:* A scale was created that examined to what degree a student gained an understanding of the learning objectives. When the complete set of five original items were subjected to a principle component analysis with varimax rotation, one factor emerged based on the Kaiser Criterion with an eigenvalue of 4.84 that explained 80.6% of the variance. Examples of these items include, “The SOS Distance Learning course has helped increase my critical thinking skills,” and “I understand how the SOS Distance Learning course will improve my performance.” The coefficient alpha for this scale was .95.

The measures for subjective learning were taken using a 5-point Likert scale. Specifically, the participants were asked to rate the following statements:



1. *I had many clarifying moments while in the SOS Distance Learning course.*
2. *The material covered in the SOS Distance Learning course caused me to think about my thinking.*
3. *The SOS Distance Learning course has helped increase my critical thinking skills.*
4. *I feel the SOS Distance Learning course has been of value to me.*
5. *My knowledge and skills have increased since taking the SOS Distance Learning course.*
6. *I understand how the SOS Distance Learning course will improve my performance.*

## **IV. Analysis and Results**

### **Overview**

The usage of the four media channels and their effects on learning outcomes were examined and the data collected was analyzed using hierarchical regression, partial correlations, and linear regression and are discussed here. The media channels were instructional methods a user could choose to engage in to reinforce the understanding of course objectives. Each channel was used independent of the other; however, some may have contained an element of the other. For example, video and avatar also include audio channels, however those elements were considered inherent to that particular instructional method.

### **Correlations**

Inspection of the correlation results in Table 1 shows audio with a strong relation with usage and learning engagement (Pearson Correlation = .234,  $p < .05$ ), and avatars having the smallest correlation with learning engagement. Learning engagement exhibited a highly significant correlation with affective reactions (Pearson Correlation = .381,  $p < .01$ ) and a low negative correlation with cognitive reactions (Pearson Correlation =  $-.074$ ,  $p < .01$ ). Affective reactions were highly correlated with learning (Pearson Correlation = .681,  $p < .01$ ). Similarly, cognitive reactions were highly correlated with learning (Pearson Correlation = .315,  $p < .01$ ).

**Table 1. Correlations among predictors and criterion measures**

	Mean	SD	1	2	3	4	5	6	7	8
1. Avatar usage	2.23	1.36	a.							
2. Video usage	2.41	1.40	.678**	a.						
3. Audio usage	2.16	1.34	.422**	.594**	a.					
4. Text usage	3.42	1.53	.166	.240*	.242*	a.				
5. Learning engagement	3.23	1.00	.074	.145	.234*	.179	.836			
6. Affective reactions	3.27	.77	.330**	.384**	.329**	.235*	.380**	.808		
7. Cognitive reactions	3.96	.81	.224*	.196	-.062	.074	.474	.636	.774	
8. Learning	3.51	1.05	.356**	.329**	.376**	.127	.204*	.681**	.003	.95

\*  $p < .05$  (2-tailed); \*\* $p < .01$  (2-tailed); Cronbach's alpha on diagonal; a. single item measure

## Hypotheses Tests

Hypotheses 1a–d were tested using the hierarchical regression. Analyses results are shown in Table 2. *H1a: Text presentations will have a positive relation with learning engagement.* Results for text exhibited a significant positive relationship with learning engagement ( $\beta = .179, p < .05$ ). As a result, **H1a is supported.**

*H1(b): Audio presentation will be more engaging than text and account for variance in learning engagement beyond that accounted for by text presentation alone.* Results in the second model show that audio accounted for significant incremental variance in learning engagement beyond that with text alone ( $\Delta R^2 = .039$ ). As a result, **H1b is supported.**

*H1(c): Video presentations will be more engaging than both text and audio and account for variance in learning engagement beyond that accounted for by text and audio presentation.* Results for the third variable, video, showed no significant increase in incremental variance ( $\Delta R^2 = .000$ ). As a result, **H1c is not supported.**

*H1(d): Avatar presentations will be more engaging than text, audio, and video and will account for variance in learning engagement beyond that accounted for by text, audio, and video presentations together.* Finally, avatars in the fourth model also showed no significant increase in variance explained ( $\Delta R^2 = .002$ ). As a result, **H1d is not supported**. Overall, the first two models confirmed hypotheses 1a & b that address the effects of text and audio, but those with H1c and d which addressed video and avatar were not supported.

**Table 2. Results of Hierarchical Regression Analyses**

		Model 1 (text)	Model 2 (text/audio)	Model 3 (text/audio/video)	Model 4 (text/audio/video/avatar)
Hierarchical step	Ind. var.	$\beta$	$\beta$	$\beta$	$\beta$
1.	Text	.179*	.130	.131	.131
2.	Audio		.203*	.209	.210
3.	Video			-.011	.025
4.	Avatar				-.053
	F	3.08	3.50	2.311	1.755
	$\Delta R^2$	.032*	.039*	.000	.002

Note: \* $p < .05$ . Dependent variable: Learning Engagement

Hypotheses H2a and H2b were tested and analyzed using a partial correlation method by controlling for the effects of individual variables. The results pertaining to the learning engagement–reactions criterion are presented here. Hypotheses 2a: *Higher levels of learning engagement will lead to higher levels of favorable affective reactions*, **was supported** as results from the model indicated learning engagement was significantly related to affective reactions while controlling for the affects of cognitive reactions ( $r = .414, p < .05$ ). The results for Hypothesis 2b: *Higher levels of learning engagement will lead to a negative relation with cognitive reactions* showed partial

support as learning engagement was negatively related to cognitive reactions while controlling for the affects of affective reactions ( $r = -.185, p = .05$ ).

Hypothesis 3a and 3b were tested using simple linear regression and the results are presented here. H3a: *Higher levels of affective reactions will lead to higher levels of learning*, was fully supported ( $\beta = .644, p < .005$ ). Hypothesis 3b: *Higher levels of cognitive reactions will lead to higher levels of learning*, **was supported** ( $\beta = .121, p < .05$ ). Results are shown in Table 3.

<b>Table 3. H3a-b regression results</b>	
	$\beta$
Affective Reactions	.644*
Cognitive Reactions	.121**
F	41.91
$R^2$	.447
Dependent variable: Learning	
* $p < .005$	
** $p < .05$	

## **V. Discussion**

### **Summary**

E-learning solutions continue to grow as organizations seek ways to educate and train their people most effectively and efficiently. It has been shown that learning engagement enables other factors beneficial to favorable learning outcomes (Carini et al., 2006), such as Kirkpatrick's level one and two. This study sought to determine the various levels of learning engagement induced by text, audio, video, and avatar instructional methods and how that related to learning outcomes.

This issue is particularly important in the case of understanding e-learning effectiveness due to the influx of technology-based education and training solutions being offered today without empirical evidence of favorable outcomes. Applying the emotional interest theory as a basis for understanding initial learning engagement in e-learning environments, this study was particularly interested in the marketing and usage of innovative avatar instructional methods and other media channels.

Using emotional appeal through its high-resolution graphical interface, interactivity, and other factors, this technology has become widely adopted and believed to be an effective method of instruction. However, there have been no known research studies to provide definitive results linking avatars and other media channels to e-learning effectiveness. Unfortunately, the emotional appeal of a multitude of e-learning technological innovations has seemingly turned people's focus away from cognitive and learning science principles, indicating more attention needs to focus in this area of research to help ensure education investments are leading to desired learning outcomes.

### ***Theoretical Foundations***

In order to link media usage to learning engagement, this study used the media richness theory, media synchronicity theory, and the emotional interest theory to predict the learning engagement levels of the four media channels used in the e-learning program examined, thereby allowing for predicted learning outcomes. It was thought, that due to its learning capacity (richness), multiple cues (vocal inflections, gestures), dual-modality, low-speed conveyance of new information, and quick feedback (convergence), that avatars would be the most effective at generating learning engagement.

Furthermore, it was predicted that higher levels of learning engagement would lead to various levels of user reactions (Kirkpatrick level 1): positively-related affective reactions and negatively-related cognitive reactions. It is intuitive to think that someone actively engaged in an optional learning activity is likely to be enjoying the experience (affective reaction), or they would not have escalated their level of activity. Conversely, the negative relation predicted with cognitive reactions was determined through a consideration of the cognitive dissonance theory, which posits that as people learn, they are entering an unknown and sometimes uncomfortable experience and would thus reflect negatively on learner's cognitive reactions.

Finally, Kirkpatrick's Level 2 (learning) was used to link Level 1 to learning effectiveness by predicting higher levels of both affective and cognitive reactions would lead to higher levels of understanding. Using Alavi and Leidner's concept of psychological learning processes that lead to learning outcomes, the paradox of negative cognitive reactions is explained: as a learner successfully progresses through the process

of dissonance (learning engagement → cognitive dissonance → sensmaking → positive cognitive reactions), the result would be higher levels of understanding.

### *Findings*

First, neither avatars nor video were found to be significantly related to learning engagement. The hierarchical regression analysis revealed the predicted incremental validity of the media channels did not exist. Conversely, the two channels thought to be least engaging, text and audio, revealed strong correlations with learning engagement.

These findings could possibly be related an access factor: the avatar and video channels are restricted to the internet-connected computer being used, whereas the audio and text provides the learner freedom of movement by having the ability to download and/or print the material and use it whenever/wherever they choose to engage in learning.

Another factor may be the demographics of the participants and their typical style of learning: educated Air Force captains/equivalents with 5 – 7 years of service have been through years of education and training and may view avatar “vignettes” or video clips as a waste of their time and prefer to simply engage in reading text for example.

A second key finding was that, while controlling for cognitive reactions, there was a significant partial correlation between learning engagement and affective reactions. Furthermore, the negative relation with learning engagement and cognitive reactions was found to be partially supported while controlling for affective reactions.

Finally, as expected, a regression analysis showed higher levels of affective reactions were highly related to subjective learning. The finding for higher levels of cognitive reactions leading to understanding was partially supported. These findings confirm the belief that a learner who is enjoying the learning experience (affective) will



be more attentive and receptive to learning objectives, resulting in increased understanding. The finding for cognitive reactions leading to understanding may have only been partially supported due to a continuation of the cognitive dissonance theory. Although the learner has progressed favorably through the psychological learning process, there is still a sense of imbalance, or a heightened awareness of how much they still don't know.

### **Limitations**

One possible limitation of the study pertains to the avatar technology used. Although defined multiple ways, avatars have come to be known as something controllable, interactive, and composed of immersive engagement, and the instructional method may be much different from what some users expected. Although considered the “richest” media in the study, and have the most appropriate levels of synchronicity for learning, the vicarious method of learning through vignettes may limit the learner's expected sense of engagement.

Furthermore, a consideration of participant's education level (bachelor's degree or higher) may indicate that an avatar or video channel for learning simply may not be cognitively appealing. By the time a participant has finished the SOS DL program, they have been in the Air Force around 5 – 7 years. After years of education and training on a number of issues, anything other than simple text or audio delivery methods may be perceived as something that slows them down, causing them to disregard the media channels altogether, or not feel satisfactorily engaged with the technique.

Another potential limitation of this study pertains to sample size. Although eleven thousand students were enrolled in the course, the research timeline permitted

only two months of data collection and resulted a sample of 95. Considering participants course completion timeframe of 18-months, more time for data collection would have increased the sample size and perhaps altered the results significantly.

A fourth limitation may be the layout of the course interface that may discourage the use of available media channels. Several of the media features were difficult to locate and might result in users not being aware of the option, or view them as insignificant due to their subdued existence. The avatar exercises, for example, are well “below the fold” at the bottom of learning modules without being “advertised” sufficiently anywhere else in the program. Both the audio and video “links” were difficult to locate and did not work at times. These potential limiting factors prohibit maximum media channel usage that may have otherwise returned different results.

The scope of this research may also be a limiting factor since the data collected was limited to Level 1 and 2 learning outcomes. The consideration of any post-training behavioral changes and/or other desired organizational outcomes resulting from the Squadron Officer School Distance Learning training experience was outside the scope of this research.

Finally, because data was collected from a single-item survey, common method bias (CMB) may have influenced the research results of this study. CMB has been identified as a main source of measurement error and problematic when using single-item measuring techniques (Podsakoff, 2003). It is possible that different results would have been obtained if a variety of measurement items had been used.

## **Theoretical Implications**

This study concentrated on optional media usage and its initiation of learning engagement and the subsequent linkages to e-learning effectiveness. In doing so, this research has exploited two main theoretical themes: educational psychology and information technology, and hypothesized avatars to be the most engaging media channel.

Educational psychology addressed the psychological learning process and how it leads to learning outcomes. Information technology theory addressed the most effective ways to communicate in order to optimize learning effectiveness. In relation to these, some perspectives have been discussed and the results of their application in this study have been shown. This section will summarize the theoretical concepts used to develop the hypotheses of this study, and discuss how they relate to the findings.

### ***Information Technology, Learning Engagement, and Educational Psychology***

Figure 1 introduced the integration of an instructional strategy with information technology in order to influence the psychological learning process. This study focused on the information technology element of instructional system designs by examining the use of media channels to influence learning effectiveness. It was hypothesized that media channels would induce varying levels of learning engagement as an element of the psychological learning process.

Based on the emotional interest theory, it was thought new and innovative avatar technology would generate the greatest interest, thereby inducing user's emotional *engagement* to a greater degree than the other channels. Consequently, as the learners in

this study indicated the least engagement with avatars, it is a noteworthy consideration that avatars are not as cognitively stimulating as first thought.

Newman described learning engagement as “the student’s psychological investment in learning” (1989). This study examined two seminal information technology theories that relate to affecting the psychological learning process to help predict which media channel would be the most engaging and lead to higher levels of learning effectiveness. The *media richness theory* was used to identify avatars as the most rich, and therefore, most engaging and possess the greatest “learning capacity” that would lead to the optimal learning effectiveness. Avatars were chosen mainly because of *two* key media richness theory qualities that gave them an advantage over the other channels: 1) multiple cues (vocal variety and gestures), and 2) immediate feedback (question/answer feature). Next, *media synchronicity theory* was used to identify avatars as having optimal conveyance (information transmission) and convergence (reaching a mutual understanding) qualities of all media channels used in the study.

The research results presented in this study indicate the avatar technology was in fact the **least engaging** of the four media channels. The theoretical implication of this result is congruent with initial reason for this study: media affects on e-learning are not sufficiently understood and studies like the one presented here are needed to clarify any common assumptions about such things as emotional interest and learning engagement.

For example, although emotional interest has been shown to engage learners initially, multimedia e-learning engagement may be short-lived once it is apparent there is little cognitive value contained therein. Clark once observed that e-learning learning is not necessarily more engaging and “can mislead students into investing less mental effort

to learn” (2009). This is consistent with what Dennis describes as the *paradox of richness*: a rich media increases engagement while simultaneously decreasing the ability to process messages due to rich elements that distract from relevant information (2005). This paradox may provide, at least in part, a theoretical explanation for the unsupported results regarding avatars and learning engagement.

### **Applications**

This study hypothesized about learning outcomes based on engagement elements of the learning process, but used a theoretical foundation that supported the ultimate objective of discovering the learning effectiveness of an e-learning program. The research findings presented here can be useful for any organization considering e-learning solutions for their education and training requirements by placing the same emphasis on proven pedagogical methods and outcomes rather than on the enjoyment factor.

### **Opportunities for Future Research**

The present study provided a foundational understanding of the effects of media usage in e-learning and its affect on learning effectiveness. Considering the demographics of the participants in this study, it would be interesting to use the theory presented here to examine another e-learning course with different levels of education, age, and experience. Similar to the SOS Distance Learning course, the U.S. Air Force has another Professional Military Education course designed for its non-commissioned officers, for example. It is recommended that the generalizable theory presented here be applied under such conditions in order to discover how much individual demographic differences affect learning engagement and learning outcomes.

Another opportunity would be to research media use in e-learning from varying generational scopes. Discussing how to manage “Generation Y,” Tulgan says people mistakenly think this generation wants to learn only from computers, when in fact they really only want to learn things that are easy to learn from computers and still value human contact (2009, p. 14). Identifying generational differences in acceptance and engagement with innovative e-learning technologies such as avatars would provide valuable insight into important ISD considerations.

## **Thesis Conclusion**

This thesis explored the affects of media usage and the linkages to e-learning outcomes. The purpose of this research was to develop a generalizable theory that can be used to assess the learning effectiveness of various media types used in e-learning environments. In order to achieve this objective, an extensive literature review was conducted involving educational psychology, information technology, and learning outcomes. As a result of this literature review, a total of eight testable hypotheses were proposed. Using a single-item survey the research methodology involved the collection of quantitative data from the U.S. Air Force Squadron Officer School Distance Learning course.

The results of this thesis were determined through a study of eight statistical models. Overall, this research helps fill a gap in existing e-learning effectiveness research by providing an understanding of how media usage in e-learning can induce learning engagement and affect learning outcomes in e-learning environments.

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## **Vita**

### **Biographical Sketch**

Master Sergeant Jason P. Royals grew up in Bay Village, Ohio. After graduating from Bay High School, he operated his own home-improvement business until 1994 when he enlisted in the Air Force on 20 June 1994. He completed technical training as a Visual Information and Intrusion Detection Systems Specialist and has built a vast breadth of experience during his career, serving at various levels from detachment to Air Force Field Operating Agency Headquarters. Sergeant Royals has also served in several contingency locations, including Saudi Arabia and Iraq.

Sergeant Royals is currently a student at the Air Force Institute of Technology (AFIT) pursuing a Master of Science Degree in Information Resource Management. Prior to attending AFIT, Sergeant Royals was a Broadcast Systems Engineering Manager at the Defense Media Activity-SA, San Antonio, TX. There, he served as a program manager providing telecommunications & engineering support to Defense Media Activity-San Antonio, American Forces Network, American Forces Radio and Television Service, and broadcast contingency sites worldwide. He also assisted in developing command-wide engineering policy and implementing Configuration Management program directives.

### **Education**

**Master of Science**, Information Resource Management, Air Force Institute of Technology, Wright-Patterson AFB, Ohio. Master's Thesis: Avatars, Media Usage, and the Linkages to E-learning Effectiveness. Expected graduation date: March 2011.

**Bachelor of Science**, Business Management/Liberal Studies, Excelsior College, Albany, New York, July 2005.

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14. ABSTRACT A fast-growing trend in e-learning environments is the investment in avatar technology to deliver an engaging and interesting learning experience. E-learning itself has limited and inconsistent research into its learning effectiveness, and this is especially true for innovative avatar instructional methods. The purpose of this research was to develop a generalizable theory that can be used to assess the learning effectiveness of various media types used in e-learning environments. A research model was developed and used to study a U.S. Air Force Squadron Officer School Distance Learning program that used avatar, video, audio, and text-based scenarios to reinforce learning objectives. It was hypothesized that media with higher levels of learning engagement (LE) would lead to more favorable reactions and thus higher levels of understanding. While text and audio showed positive LE results, the hypotheses for both avatar and video influence on LE were not supported. Results also showed full and partial support for LE leading to favorable learning outcomes. The model developed in this research identified the learning effectiveness of an e-learning program and can be used to guide education and training investment decisions based on proven learning outcomes rather than the surface appeal of emotional interest and engagement features.					
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